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ABSTRACT

Since there are no clearly defined set of priorities on which to base a program of study in secondary school electronics, this study determined to what extent New York State high school electronics programs are preparing students with the technical competencies, knowledge, and equipment orientation necessary for employment in the electronics field based on industrial demands in the greater Rochester (New York) area. Data were collected by a questionnaire (developed for the study) from a stratified sample of electronics industries in the Rochester area. Data analysis indicates that the goals/priorities of current electronics programs are not reflecting changes in industry, which desires graduates who can troubleshoot, make measurements with test equipment (especially oscilloscopes), solder, and have a strong preparation in practical electronics applications. In comparing data to one school's curriculum, a discrepancy was found between what industry considers as essential skills/knowledge and what is being taught, indicating that the curriculum needs to be modified to prepare students with competencies needed for employment. Supporting documentation (including questionnaire) is included in nine appendices. (Author/JN)

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WHAT EXTENT ARE CURRENT NEW YORK STATE HIGH SCHOOL ELECTRONICS PROGRAMS PREPARING STUDENTS WITH THE COMPETENCIES NECESSARY FOR EMPLOYMENT IN THE ELECTRONICS FIELD BASED ON INDUSTRIAL DEMANDS IN THE GREATER ROCHESTER AREA

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A Thesis

Submitted in Partial Fulfillment
of the degree of
Master of Science in Education

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PREFACE

This study is concerned with the collection of data to provide a basis for decision making concerning high school electronics curriculum. The primary objective is to provide data, based on industrial demands, to determine the competencies, knowledges and equipment orientation required of high school students entering the electronics field upon graduation. It is not the purpose of this study to develop an updated electronics curriculum.

The author wishes to express his appreciation to his adviser, Dr. J. Michael Adams, for his guidance and assistance throughout this study. A note of thanks is given to Mr. Gerald Buss and Mr. Harry Hawkins for their assistance in the preparation of the first rough draft of the questionnaire. Thanks is also given to Mr. James E. Good for a supporting curriculum and to Ms. Mary Jo Dibble, for her assistance in typing earlier drafts of the manuscript. In addition, appreciation is extended to the many electronic industries in the greater Rochester area for their support in supplying the data for this study.

Finally, special gratitude is expressed to my wife, Shirley, our son Timothy, and our daughters, Kimberly and Susan, for their understanding, encouragement, and many sacrifices.

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CHAPTER I

INTRODUCTION

In 1948, Bell Laboratories perfected the first working junction transistor. Since that time, the electronics industry has developed at a rapid rate. In 1954, Regency, a manufacturer of radios, marketed the first transistor radio. Fairchild, a transistor manufacturer, in 1959, applied for the first integrated circuit patent and 1961 saw the sales of the first commercial integrated circuit. By 1963, transistors exceeded vacuum tube usage in the United States and in 1974 the first 16 bit single chip microprocessor was developed. In 1976, the first computer on one board was developed, leading to a rapid growth in the microprocessor field (Dummer, 1977).

These examples reflect just a few of the major advances in electronics, in the last thirty years. The 1980s will be an era of the new technology, electronics, based on the growth that has occured to date (Friedmann, 1979).

Background

Adam Osborne, founder of Osborne & Associates, observed in his book Running Wild, the Next Industrial Revolution:

> We are already five years into a new industrial revolution, the impact of which will rival the first industrial revolution.

> Of all jobs in the industrial world, perhaps half will be eliminated during the next twenty-five years. From assembly line to stock brokerage, blue collar and white collar jobs alike will disappear. The jobs that do remain will make new demands on job seekers and job holders.
>
> . . . .
>
> The new industrial revolution was created by the semiconductor industry (1979, p. vii).

Victor Walling, Thomas C. Thomas and Meredith Larson, associates of SRI International (formerly Stanford Research Institute), Menlo Park, California, observes in an unpublished paper of May, 1979, that the new electronic technology appears to have reached and passed a "take off" point, after which its development progresses geometrically in speed, diversity and quality. Eugene V. Solberg, an associate of the Wisconsin State Board of Vocational, Technical and Adult Education in Madison, Wisconsin, noted in a June, 1978 unpublished paper, that development in the field of electronics has been so rapid that frequently the interval between development and marketing results in obsolescence almost as soon as equipment reaches the consumer.

In 1979, Edward A. Friedmann, Dean of the College at Stevens Institute of Technology wrote in a magazine article:

> I envision an impact of technology in the 80's that will be different in kind from what has been preceived in the past. In the 80's, America will be living with a technological environment that will be significantly more pervasive with more profound impact on our lives than today (1980).

Robert F. Tinker, a researcher with the Technical Education Research Center (TERC) of Cambridge, Massachussetts, in a September, 1979 article states:

> There is no doubt that the increasing importance of electronics in modern life will make it ever more essent-

> ial that we teach about electronics. But again, the past is no guide to the future. Not only are most electronic courses out of date, but they not even use an appropriate approach (p. 28).

Everett N. Israel, Professor and Chairperson of the Industrial Technology Department at Illinois State University, in February, 1981, observed:

> The average rate of change in industry or technology has been reduced from 8 to 15 years to 1 to 5 years. The rate of change in education is projected to be 10 to 20 years, with some educators still projecting that the average U. S. school lages behind 15 to 25 years.
>
> Because new technology is developing at a faster rate than education is updated, major changes are not studied in the industrial arts laboratory until 16 to 30 years later (p. 3).

C. Dale Lemon, Professor of Vocational Education at the University of Wyoming states: "I believe one of the major challenges to industrial arts education is its relevance to the future" (1981, p. 4).

Victor Walling, Thomas C. Thomas and Meredith A. Larson further states: "Public schools may be the last to adopt the new technology of electronics" (1979, p. iii).

Typically the study of career preparation is left to the Board of Cooperative Education Services (BOCES), New York State's system for providing vocational education at the secondary level. However, in the greater Rochester area, the BOCES schools do not teach a comprehensive electronics program that leads to employability. Through this study a foundation will be laid to assist in the creating of an electronics curriculum that will do so. Typically high schools are charged with teaching electronics, but due to the rapid changes in electronics, they are hard-pressed to keep up.

Industry has frequently chosen to hire high school students in the electronics field because of their well-rounded education (Good, 1981).

Statement of the Problem

Walter J. Brooking, Consultant, Technical and Postsecondary Education, Washington, D. C. states:

> Electronics is one of the most dynamic fields in the country today. Perhaps the biggest challenge is . . . to keep up to date with the newest developments (1979, p. 4).

At the present time there are no clearly defined set of priorities on which to base a program of study in electronics. The purpose of this study points to the main research problem: To what extent are current New York State high school electronic programs preparing students with the technical competencies, knowledges and equipment orientation necessary for employment in the electronics field based on industrial demands in the greater Rochester area.

Purpose of the Study

From the data analysis and results tabulated, a foundation will be laid for the generation of a new electronics program. An objective of this study is to collect and tabulate data which could be used to base a new electronics program.

A second objective is to assist in establishing guidelines to determine appropriate competencies, knowledges and equipment necessary to maintain a current electronics program.

Need for the Study

James E. Good, District Supervisor of Industrial Arts and Vocational Education, Greece Central School District, Greece, New York notes:

> Most electronic programs start with the resistor color codes followed by Ohm's Law, series, parallel and equivalent circuits. This creates a problem in that, it is too mathematical and too far removed from the practical application for most students at most levels (1981).

The most current New York State electronics curriculum guideline was published in 1967. In the area of vocational education, a Syllabus in Trade Electricity-Electronics was published in 1976 by the University of the State of New York through the State Education Department, Bureau of Occupational and Career Curriculum, in Albany, New York. Due to the rapid transition in electronics, these curriculum guides are not in line with the new trends, as they still carry a section on vacuum tubes. In 1963, transistor usage exceeded vacuum tube usage in the United States; why then is the New York State curricular emphasis still on vacuum tubes?

Another curriculum source is the Curriculum Development Library marketed by Pitman Learning, Inc.. The Curriculum Development Library is a major microfiche collection devoted solely to curriculum documents and guides that show educational requirements, programs and teaching practices for grades K-12, early childhood education and adult basic education in the United States and Canada. It is designed to encourage a wide and

systematic sharing of the large number of curriculum documents that are produced each year. The Curriculum Development Library was created to enable all curriculum developers to have the best possible access to the work of their colleagues, so that their efforts can add to, not duplicate work already done.

The Curriculum Development Library does carry some curricula on electronics. The newest one is dated 1978 and does not include the current state of the art in electronics! Especially missing is any study of integrated circuits.

There is a serious need for a data base to determine what should be included in today's electronic curriculum. The point of this study is to determine the extent of the necessary updating. This is not a study to provide an updated curriculum in electronics, but rather to provide a basis for intelligent decision making.

The electronics industry can be broken down into four distinct categories: military, industrial, consumer, and components (Sullivan, 1975). Each represents specific concerns and requirements. Any study, to establish a basis for curriculum innovation should, of necessity, include all four categories.

A major difficulty in any study is to identify a population center that contains all necessary elements, and is at the same time, logistically manageable.

The greater Rochester area was chosen as a base for this study because of the following factors:

1. it has a high concentration of electronic industries;

2. it contains all four of the major industrial categories;
3. it is representative of the American electronic industries;
4. it is a finite group, easily reachable by this researcher.

Research Questions

1. Are the goals and priorities of the current electronic programs accurately reflecting the changes in industry?
2. What competencies does industry require of high school students entering the electronics field upon graduation?

CHAPTER II

REVIEW OF RELATED LITERATURE

Dyrenfurth and Householder (1979) in Industrial Art Education: A Review and Synthesis of the Research 1968-1979 for the National Center for Research in Vocational Education, noted that:

> One of the more popular techniques in industrial arts curriculum research has been the survey of industrial representatives in order to identify potential content for industrial arts in a specific area. Existing industrial art programs are surveyed and the degree of correspondence between such programs and recommendations from industry are analyzed. In many ways, the outcome is predictable, since industrial arts never has pretended to precede industry in the development of technological processes. However, the studies are valuable in that they identify industrial related content (p. 44).

Several persons have performed studies in the various areas that comprise industrial arts. These areas are: wood, metal, drafting, graphic arts, power/transportation, plastic and electricity/electronics. Of these areas, electronics is of concern for this study.

From reviewing previous literature, little has been done in the field of electronics and industry. It is concluded that to review literature from other areas and their relationship to industry would be of benefit. Techniques used to poll industry and education will be adaptable to electronics. It is further concluded that time will be saved by avoiding some of the problems involved with the previous searches in the other areas of industrial arts.

Results of Previous Search

Quier (1969), Boyd (1973) and Calhoun (1973) all studied certain aspects of wood technology. Quier sent out questionnaires to 100 randomly sampled teachers in woodworking and to a panel of experts in the woodworking industry. Eighty-seven percent of the teachers and 100 percent of the industry experts responded. Boyd used a different approach, in that, he did personal interviews. He interviewed presidents, vice-presidents, executives, directors, managers, superintendents and engineers involved with wood, related materials and processes. He also interviewed teacher educators in woodworking programs. Calhoun, like Quier, sent out a questionnaire. He sent it to 260 randomly selected companies of the 800 listed in the Standard and Poor's Register of Corporations, Directors and Executives. He also sent questionnaires to 116 randomly selected teachers from the Industrial Teacher Education Directory. All three were consistent in their findings, that the processes used in the woodworking industry were not what was offered in the various programs in the schools.

Falls (1968) studied metal and woodworking used in the manufacturing industries and the junior high school. He did a survey of 240 personnel directors of metal and woodworking firms. He also surveyed 216 junior high school industrial art teachers to identify course content. From his findings, he noted that teachers were more concerned about skills than was industry. Furthermore, industry did not feel that course con-

tent was suitability selected.

In 1974, Hildebrand conducted a study in drafting. He sent a survey questionnaire, he developed from a review of literature in the drafting field, to all four-year institutions with an industrial arts drafting program. He also sent questionnaires to 300 stratified randomly selected industries using draftsmen. From the data he collected, he concluded that educational institutions should seek to copy industrial practices.

Glogovsky, in 1970, reviewed the relationship between graphic art programs and recommendations from the graphic art industries. He sent out two separate questionnaires of graphic art processes. He sent one questionnaire to 135 graphic art industries which had a net capital of three hundred thousand dollars or more. He sent the other questionnaire to graphic art teachers who had the highest academic rank at each of the education institutions which offered a Bachelor of Science or a Bachelor of Art in education. He concluded that a difference did exist between what was being taught and industry's recommendations.

Brown (1975) published a research study in Man/Society/Technology in the communications area of graphic arts. He found that most programs tend to lag behind what industry was doing. Salvagin (1974) did a study concerning the photographic field. He surveyed selected industries and educational institutions in nine states. From his survey, he discovered that there existed a substantial need for instruction in the area of photography and that industry placed different priorities than the educators in the field.

In 1970, Grannis sent a questionnaire to all secondary schools that taught power mechanics and to industries that represented the power area. He noted that there was a substantial difference between what industry recommended and what was taught in the power mechanics programs.

Envick (1968) did a study on the equipment, materials and processes used in the plastic industries. He surveyed 127 industries which had two or more different processes and 79 high schools which offered at least a nine-week course in plastics. The purpose of his survey was to identify and compare the major components of the plastic industries. He concluded that schools and industries shared different opinions about which processes should be taught in the industrial art programs. He further noted that the industrial art programs could not keep up with the different equipment that is typically used by industry.

Kale (1974) did a study on microwave electronics. He sent questionnaires to 31 manufacturing companies which made microwave devices and equipment and to 29 companies which used microwave communication equipment. He discovered that much of the material being taught in microwave electronics is no longer used in industry.

In 1979, Lennox completed a study of electronic instructors and industries perception of existing curricula. He hand-delivered, and received 100 percent response, quesionnaires to the instructors in the local community colleges and to 122 students enrolled within. He also delivered questionnaires to 52 stratified samples of electronic companies. From his conclusions he noted a difference between instructor satisfaction with the course material and students and industries request to

shift emphasis from the theoretical to the practical approach.

Dybas (1980) did a study to determine the curriculum content in an industrial arts teacher education program. He used a delphi approach and brought together an expert delphi panel which represented the following areas: industrial electronics, technical electronics, engineering electronics, military electronics, industrial arts electronics and technical publications. The panel's conclusions were to place priorities on the simplification and practical application of electronics.

In developing a questionnaire, it is essential to pilot an instrument prior to formal distribution. It can reveal defects that can be corrected prior to the final form being printed, and can streamline data collection procedures. Questionnaires should only be sent to those who possesses the desired information and are assured a response returned (Best, 1981, p. 177).

Harold W. See, in 1957, discovered that a higher return could be obtained if the original request was sent to the administrative head of an organization, rather than directly to the person who has the desired information.

Personally administered questionnaires have some of the same advantages as those of the interview. They establish rapport with the resondent, explain the purpose of the interview, clarify the items and yield a much higher return rate. However, attempting to travel to each respondent in order to administer the questionnaire is generally impractical and eliminates the advantage of being able to contact a large sample (Gay, 1976, p. 128).

Validity and reliability of a questionnaire deserve careful consideration. Content validity may be determined by a panel of experts. Reliability may be inferred by a second administration of the instrument. It may also be estimated by comparing responses of an alternate form with the original form (Best, 1981, p. 179).

Summary

Survey Procedures

Looking at the various areas and the techniques used to gather data, it is noted that roughly 60 to 70 percent of the studies used a questionnaire while the remainder used other methods. It is also noted that the highest percentage of responses returned were on those questionnaires that were hand-delivered.

Survey Results

To briefly summarize the results of the material reviewed, the following points are noted:

1. There is a substantial difference of opinion between industry and industrial art programs about what methods/processes should be taught.

2. Teachers in industrial art programs are placing more emphasis on "skill" and not enough emphasis on course content according to industry.

3. Industrial art programs should be copying the "practices" used in industry even though industry has more and different equipment

than is available in the program.

4. Industrial art programs are teaching material that is no longer used by industry.

5. Electronics should be taught with a strong emphasis on practical application.

Implication for this Study

1. A questionnaire will receive the highest response when it is hand-delivered.

2. Industry and educators do not share the same enthusiasm about what is taught.

3. There needs to be more emphasis on the practical approach, with less emphasis on skill.

4. The curriculum needs to be updated to reflect the rapid change in technology.

5. A pilot study should be conducted on the questionnaire.

CHAPTER III

METHODOLOGY

Definitions

The following are terms that are used in this study:

1. BOCES: Board of Cooperative Education Services. State of New York's system for delivering vocational training at the secondary level.

2. Curriculum: A general overall plan of the content of instruction that a school should offer to the student by way of qualifying him/her for entrance into a profession or vocational field (Good, 1973, p. 157).

3. Electronics: Pertaining to electron devices or to circuits or systems utilizing electron devices (Markus, 1978, p. 213).

4. Industrial Arts: An area of education dealing with socio-economic problems and occupational opportunities involving experience with a wide range of materials, tools, processes, products, and occupations typical of an industrial society (Good, 1973, p. 298).

5. Questionnaire: A list of planned written questions related to a particular topic, with space provided for indicating the response to each question; intended for submission to a number of persons for reply (Good, 1973, p. 464).

6. Technology: The branch of knowledge which deals with the

various industrial arts (Thatcher, 1967, p. 860).

7. Vocation: A calling as to a particular occupation, business or profession (Good, 1973, p. 645).

8. Vocational Education: A program of education below college level, organized to prepare the learner for entrance into a particular vocation (Good, 1973, p. 645).

Assumptions

In conducting this study, the following basic assumptions were used.

1. The people filling out the questionnaire were knowledgeable in the area of electronics.

2. Respondents accurately and honestly answered the questionnaire.

3. The information collected by this study has sufficient universality so that other schools will benefit from the data in the preparation of their electronic programs.

Delimitation

For the purpose of this study, the following delimitation was made: this study will be limited to the electronics industries operating in the greater Rochester area of New York state.

Limitations

As with many studies, there are certain conditions that go beyond the control of the researcher that will place restrictions on the outcome of the study. The following were limitations imposed on this study.

1. The number of firms in the greater Rochester area in the field of electronics.

2. The number of firms in the greater Rochester area that were willing to participate.

3. The time constraint placed on this study by the university.

Development of the Instrument

The questionnaire used with this study was developed through a two-part process. The first part consisted of translating the objectives from the Syllabus in Trade Electricity-Electronics, published by the University of the State of New York, into a tabular form and adding items identified as developing since the guide was published. This form was sent to a panel of experts which consisted of three teacher educators, one high school electronics teacher and one representative from industry. The instrument sent to the panel of experts was used to develop the final questionnaire (Appendix C). Appendix B consist of a summary of the data received from the panel of experts. Appendix A is the instrument sent.

Briefly summarizing the panel of expert's recommendations, the following is noted. They recommend that some mention must be made as to the course length and to change the word "knowledge" to "understand"

In many instances they recommended the addition of words to clarify certain statements. In most cases where the word "theory" appeared, they recommended it to be changed to "basic concepts". They felt that the word theory implied going into great depth. Certain items were recommended to be deleted or combined where the item appeared to be too specialized.

Prior to formal distribution of the questionnaire, a pilot test was conducted on five industrial firms of electronics in Oswego, New York. The conclusion of the pilot test indicated that the questionnaire was valid and that it could be properly understood. This step was essential as it reinforced the questionnaire's usability and streamlined the final data collection procedures.

Selection of the Subjects

The industries used in this study were taken from a listing of industries in the Directory of Manufacturing Industries of Rochester and Monroe County, New York published by the Business and Economic Development Department of the Rochester Area Chamber of Commerece. The electronic industries were identified and categorized by the number of employees hired. Appendix D shows the list of industries chosen for this survey. The number of employees are not identified at the request of several companies.

The stratified samples of industries were selected using the following non-biased method. A chart was constructed based on the number of employees. Because of the confidential nature of this informa-

tion, the chart is not included. Companies were selected to fit the chart based on the number of personnel employed. To determine what companies were selected, a list was made of the electronic companies in a chronological order of the number of employees. As much as possible, random selection was made from the list to fit the chart. In some instances there was only one company to fit a particular group.

Eighty-five percent of the electronic companies hire 500 or less personnel. Altogether this represents only nine percent of the electronic personnel hired in the greater Rochester area. One questionnaire was sent per 500 employees or less. In companies of greater than 500, one questionnaire was sent per multiple of 500.

Collection of the Data

Based upon the review of literature (Lennox, 1979) and results from the pilot study, all questionnaires were hand-delivered to each respondent. Prior to delivery, a time was established to leave the questionnaire by contacting the key personnel in each company via telephone. At delivery, a time was established for pick-up of the questionnaire. Also at delivery, a short introduction about the survey was given and all questions were answered. At pick-up a series of questions were asked to determine whether the respondent clearly understood the questionnaire. Using this method, over ninety percent of the questionnaires were received.

CHAPTER IV

RESULTS

The questionnaires (Appendix C) were hand-delivered to each of the electronic companies listed in Appendix D. Two days later the questionnaires were picked up as agreed by each company. Those companies that were not ready to have their questionnaires picked up, were called each day until they were ready. Out of 47 questionnaires delivered, five were requested for personal copies of the survey and 38 were returned. This represents a 91 percent return rate on the questionnaire.

Of the 38 questionnaires received; 31.6 percent were answered by management of electronic companies, 28.9 percent by supervisors in electronic companies, 26.3 percent by electronic engineers and 13.2 percent were answered by electronic technicians.

Analysis of the Data

The raw data received from the companies was analyzed by five methods. These methods include: ranking the results of each item by groups of personnel responding, compiling the total results of each item, determining the percentage of agreement of each item, developing a hierarchy of importance of the basic concepts and comparing the results with a current electronic program.

Appendix E ranks the results of each item. Consideration was

given to the groups of people responding. The groups were categorized as management, supervisors, engineers and technicians. Each item was identified as essential, beneficial, nice to know, limited use and unimportant. Numerical values were assigned as: 5.00 for essential, 4.00 for beneficial, 3.00 for nice to know, 2.00 for limited use and 1.00 for unimportant. In tabulating each item's numerical score, the scores for each item was added together and the mean value determined for the four groups. The mean value is the value shown on the chart in Appendix E. A visual representation of this data is exhibited in figure 1 for the knowledge items and figure 2 for the skill items. The four groups are represented in both figures 1 and 2 by superimposing each group over the others.

Appendix F displays the total mean score of all the data received. These totals may not agree with adding the numerical values shown in Appendix E and determining the average, due to the rounding-off of the final results of the individual groups. The totals shown in Appendix F was determined by adding the raw scores of each item and deriving the mean value for the total of all the groups. The results are given as a numerical value as well as a graphic interpretation of the results. The results are also shown, superimposed over the four major groups in figures 1 and 2.

Appendix G shows the percentage of agreement of each item. The percentages were determined from the data shown in Appendices E and F. It has been broken down to the four major groups and an overall listing. The percentage was found by dividing each value by five, the highest

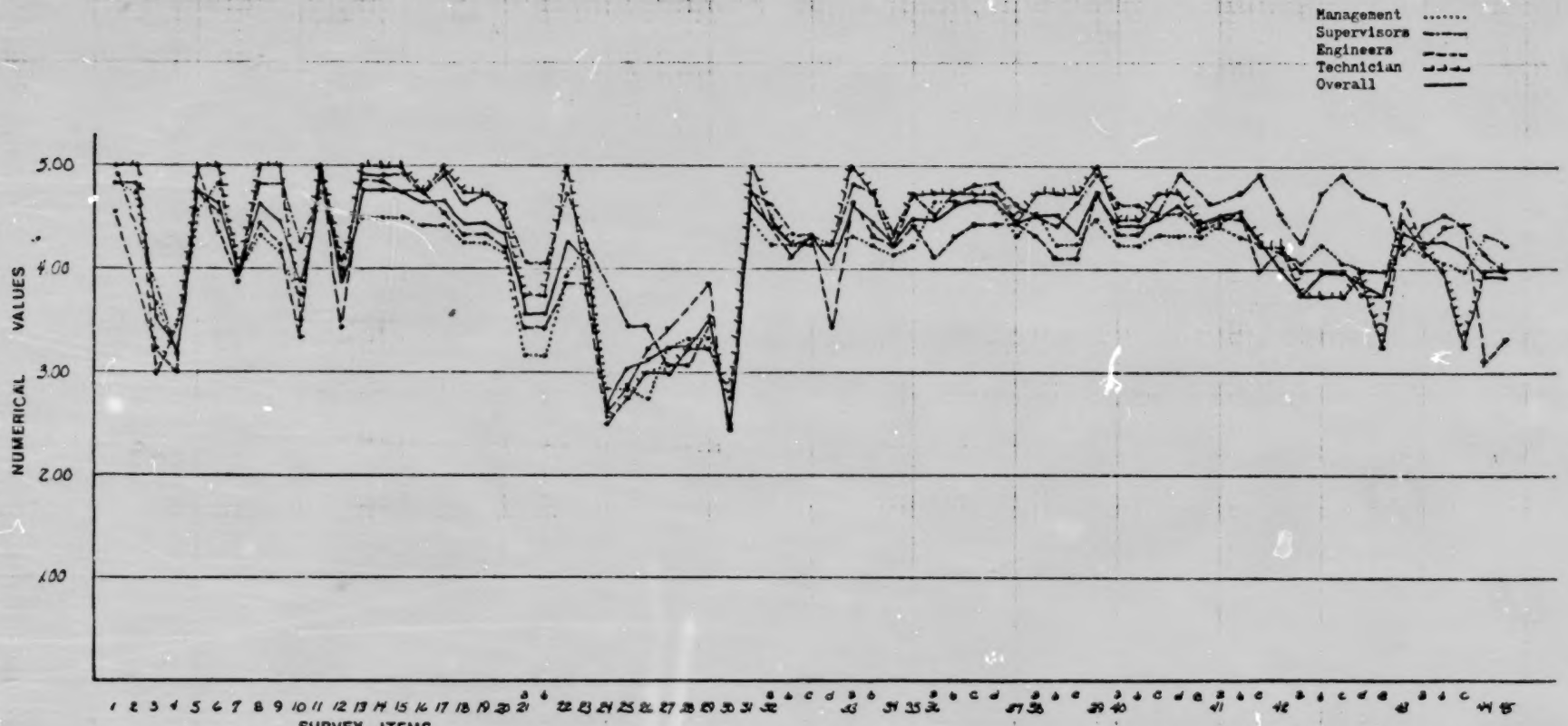

Figure 1. Knowledge Items

22/23

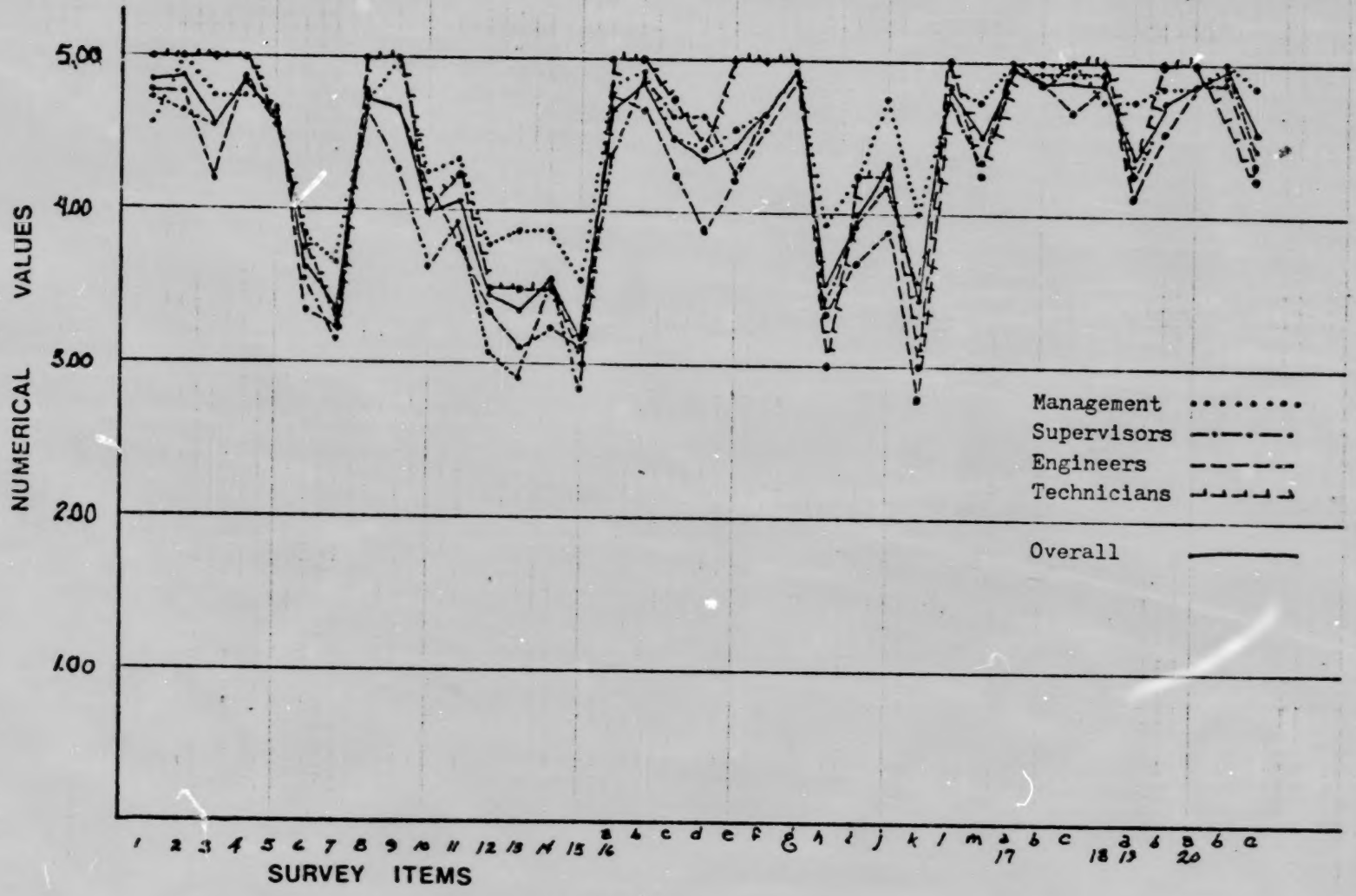

Figure 2. Skill Items

value assigned. The overall listing was completed from the total of the raw scores, therefore might not average the total of the percentages shown.

Appendix H is a ranking of the importance of the basic concepts in electronics. This represents ordinal data and was located on the last page of the questionnaire. The data has been separated into the four major groups and shows how each group ranked them. Also an overall rating is shown for all the groups. These rankings were determined by adding the ranks given by each of the groups. Numbers were reassigned by assigning one for the lowest score, two for the next lowest until all sections have been assigned a rank.

Appendix I is a table showing a numerical listing of the items of the survey compared to a current electronics program. The curriculum of the Greece Central School District was used as a representation of a high school electronics program. Greece teaches a full three or four-year electronics program. The items from the Greece curriculum were compared against the survey items. Each item was located and identified on the chart. The Greece curriculum was broken down as follows: L1 for level one program, L2 for the level two program and L3 for the level three program. A list of essential items were established as those items that achieved 4.01 or better from the list of the surveyed items in Appendix F. It should be noted that the value of 4.01 is just a recommendation. The purpose of this study is to provide a data base and not to produce a curriculum. The essential items were located on the chart and identified as such. From the above data, a list was generated as essential but not

taught in the Greece electronics program. A second list was generated on those items that are considered non-essential but taught. A comparison was made between what was taught and those items deemed essential and not taught and those items considered essential and taught.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECCOMENDATIONS

Summary

The goals and priorities of current electronic programs are not accurately reflecting the changes in industry. Industry and education both agree that basic electronics and solid-state electronics are the first priorities, after which both disagree. According to the Syllabus in Trade Electricity-Electronics, published by the University of the State of New York, the emphasis is on communications. Industry feels the emphasis should be on digital and computer electronics. This is keeping in tune with the rapid changing of digital and computer contolled equipment.

The purpose of this study was to explain the relationship between what is being taught and what is needed in electronics. The two research questions to be answered are: Are the goals and priorities of the current electronic programs accurately reflecting the changes in industry? What competencies does industry require of high school students entering the electronics field upon graduation?

Interpretation of the Data

It is beyond the intent of this study to provide concrete con-

clusions. Rather the purpose of this study is to report as the research questions state. To provide a guide for the interpretation of the data compiled by this study, the following information is given.

If a cutoff point has to be derived, to determine what items are to be taught and what items are to be deleted, a value of 3.50 might be selected. This value represents 70 percent of agreement among the industrial personnel in teaching a particular item. Seventy percent is an arbitrary value and could just as easily been 60 or 80 percent. The value of 70 percent will be used for this example.

Based on the knowledge that 70 percent is the cutoff point and anything below 70 percent is to be considered invalid for teaching purposes. The following items are to be considered dropped from the curriculum, based on the items of the questionnaire.

Knowledge items	Topic
4	Printed circuit board fabrication
24	Residential wiring codes
25	Industrial wiring codes
26	Industrial/residential controls
27	Receivers/transceivers
28	Conductive communications
30	Vacuum tubes
Skill items	
7	Printed circuit board fabrication
12	Using sheet metal equipment
13	Using basic metal and woodworking tools

15 Using bandsaw

16k Using vacuum tube tester

The essential items, those items that achieves 4.01 or better, that might be included in a high school electronics program would be the following items. It should be noted that those items that are considered beneficial would also be taught, but the importance wouldn't be as great.

An electronics program must require the student to know:

Electrical safety

Electronic schematic symbols

Electronic troubleshooting

Soldering techniques

Test equipment familiarization

General DC electron theory

Ohm's law

Series, parallel and series-parallel circuits

Resistive circuit analysis

AC principles and terms

RL, RC and resonance circuits

Transistors

Special semiconductors

Transistor amplification

Transistor oscillators

Transistor switching

Power supply concepts

Integrated circuits and families

Basic digital electronics

Basic logic gates and symbols

Basic digital circuits

Basic linear circuits

Basic concepts of microprocessors

An electronics program must require the student to be able to:

Use standard resistor color codes

Identify components used in electronics

Use basic electronic hand tools

Read and understand schematic diagrams

Breadboard circuits from schematic diagrams

Troubleshoot and repair a printed circuit board using a schematic diagram

Hand solder

Properly use various fasteners

Use the following test equipment

Analog and digital miltimeter

AF and RF signal generators

Function generator

Frequency counter

Oscilloscope

Transistor tester

Power supply

Logic probe

Use a multimeter to measure voltage, current and resistance

Use an oscilloscope to measure voltage and frequency

Test transistors

Troubleshoot using a multimeter, oscilloscope or logic probe

Conclusion

The two research questions to be answered by this study are:

1. Are the goals and priorities of the current electronic programs accurately reflecting the changes in industry?
2. What competencies does industry require of high school students entering the electronics field upon graduation?

In response to the first question, the answer is no. Based on the results tabulated in Appendix I, it can be seen that the program used for comparison is not teaching 14 percent of the knowledge items considered essential by industry. Furthermore, it is teaching 20 percent of the knowledge items that are considered non-essential. In the skill area, 52 percent of the items considered essential are not taught, compared with 23 percent of the non-essential items that are taught. In the program used for comparison, more emphasis needs to be placed on the practical areas.

Industry requires a student graduating with a background in electronics, to be able to troubleshoot, make various measurements with different pieces of test equipment, especially the oscilloscope and to be able to solder. Industry places more importances on having a student being able to do something than having him know something. There are more areas to know in electronics than perhaps in any other single field of technology, but there are only a few basic pieces of test

equipment that a student has to know. Industry does expect a student to know where to find the information and to be familiar with the reference books used in industry.

Recommendations for Further Studies

It should be realized that this study was concerned with only industry and its needs. Educators input for the final analysis were ignored because of certain limitations. A study should be made among educators in the industrial arts electronic programs to compare results. A comparison between vocational education, career education, industrial arts and two year technical progams could also supply significant information.

Obviously, expanding the study to a larger population base with a national scope, could further validate these results.

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APPENDIX A

ROUGH DRAFT

TO

PANEL OF EXPERTS

21 July 1981

Dear Respondent,

The following is a rough draft of a questionnaire to be used for gathering information from industry. The purpose of the questionnaire is to gather data, to determine if the materials presented in high school electronic programs are adequate for preparing a student for employment in the electronics field. This study will be conducted from a stratified sample of the electronic industries in the greater Rochester area.

The argument that may be encountered is that vocational education and not industrial arts is charged with career preparation. In the Rochester area, the BOCES (Board of Cooperative Education Services) do not provide a comprehensive electronics program as with the local schools. Even as most schools teach electronics, they are hard-pressed to keep up with the rapid changes in electronics.

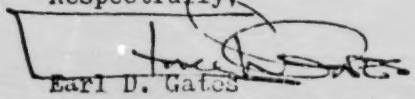
It has further been experienced that industry frequently chooses to hire high school students into the electronics field because of their well-rounded education.

I am asking you to preview the questionnaire to determine the following items:

1. the use of proper wording;
2. insure that adequate content is included;
3. check the completeness of each item.

Please feel free to write on the questionnaire. All responses will be kept confidential.

Respectfully,



Earl D. Gates
Greece Olympia High School
Rochester, New York

DIRECTIONS

Review the following items checking for proper wording, adequate content and completeness of the item.

- If a "No" response is indicated, write down what the problem is and a possible solution if you have one.
- If a "Yes" response is indicated, it will not be necessary to circle it. An item with uncircled responses will indicate that it is okay.

Feel free to add items that may be missing or cross out items which you consider excess.

All responses will be kept confidential.

At the completion of the electronics program, the student will be able to demonstrate knowledge of the following areas:

		Properly Worded		Adequate Content		Item Complete	
1.	Safety with electricity.	Yes	No	Yes	No	Yes	No
2.	Common electronic symbols as used with schematic diagrams.	Yes	No	Yes	No	Yes	No
3.	General Electron theory.	Yes	No	Yes	No	Yes	No
4.	Conventional sources of electricity.	Yes	No	Yes	No	Yes	No
5.	Cells and batteries; series and parallel connections.	Yes	No	Yes	No	Yes	No
6.	Resistive circuits a. series. b. parallel. c. series-parallel.	Yes	No	Yes	No	Yes	No
7.	Ohm's Law.	Yes	No	Yes	No	Yes	No
8.	Kirchoff's Law.	Yes	No	Yes	No	Yes	No
9.	Complex resistive circuit analysis.	Yes	No	Yes	No	Yes	No
10.	Inductive circuits.	Yes	No	Yes	No	Yes	No
11.	Capacitive circuits.	Yes	No	Yes	No	Yes	No
12.	Resonance circuits a. RI. b. RC. c. RCL.	Yes	No	Yes	No	Yes	No
13.	Generator theory a. AC. b. DC.	Yes	No	Yes	No	Yes	No
14.	Motor theory a. AC b. DC	Yes	No	Yes	No	Yes	No
15.	Transformer theory.	Yes	No	Yes	No	Yes	No
16.	AC principles and terms.	Yes	No	Yes	No	Yes	No

		Properly Worded		Adequate Content		Item Complete	
17.	Fuses and circuit breakers.	Yes	No	Yes	No	Yes	No
18.	Distribution of electricity.	Yes	No	Yes	No	Yes	No
19.	Switches.	Yes	No	Yes	No	Yes	No
20.	Residential wiring.	Yes	No	Yes	No	Yes	No
21.	Industrial wiring.	Yes	No	Yes	No	Yes	No
22.	Industrial controllers.	Yes	No	Yes	No	Yes	No
23.	Appliance theory and repair.	Yes	No	Yes	No	Yes	No
24.	AM Radio theory.	Yes	No	Yes	No	Yes	No
25.	FM Radio theory.	Yes	No	Yes	No	Yes	No
26.	Television theory.	Yes	No	Yes	No	Yes	No
27.	Audio and high fidelity theory.	Yes	No	Yes	No	Yes	No
28.	Telemetry theory.	Yes	No	Yes	No	Yes	No
29.	Radar theory.	Yes	No	Yes	No	Yes	No
30.	Antenna theory.	Yes	No	Yes	No	Yes	No
31.	Telephone theory.	Yes	No	Yes	No	Yes	No
32.	Telegraph communications theory.	Yes	No	Yes	No	Yes	No
33.	CB Radio theory.	Yes	No	Yes	No	Yes	No
34.	Amateur radio theory.	Yes	No	Yes	No	Yes	No
35.	Sonar theory.	Yes	No	Yes	No	Yes	No
36.	Teleprinter theory.	Yes	No	Yes	No	Yes	No
37.	Facsimile theory.	Yes	No	Yes	No	Yes	No
38.	Electronic navigation systems.	Yes	No	Yes	No	Yes	No
39.	Transducer utilization.	Yes	No	Yes	No	Yes	No
40.	Basic semiconductor operation.	Yes	No	Yes	No	Yes	No
	a. FET and MOSFET	Yes	No	Yes	No	Yes	No
	b. UJT	Yes	No	Yes	No	Yes	No
	c. SCR	Yes	No	Yes	No	Yes	No
	d. Triac	Yes	No	Yes	No	Yes	No

	Properly Worded		Adequate Content		Item Complete	
41. Transistor amplification theory	Yes	No	Yes	No	Yes	No
a. low power.						
b. high power.						
42. Transistor oscillator theory.	Yes	No	Yes	No	Yes	No
43. Transistor switching theory.	Yes	No	Yes	No	Yes	No
44. Power supply theory	Yes	No	Yes	No	Yes	No
a. half wave.						
b. full wave.						
c. filtering.						
d. regulation.						
45. Basic vacuum tube theory.	Yes	No	Yes	No	Yes	No
46. Integrated circuits.	Yes	No	Yes	No	Yes	No
a. TTL	Yes	No	Yes	No	Yes	No
b. CMOS	Yes	No	Yes	No	Yes	No
47. Digital electronics theory.	Yes	No	Yes	No	Yes	No
a. Binary system.	Yes	No	Yes	No	Yes	No
b. Hexidecimal system.	Yes	No	Yes	No	Yes	No
48. Boolean algebra functions.	Yes	No	Yes	No	Yes	No
49. Logic gates.	Yes	No	Yes	No	Yes	No
50. DeMorgan theorem.	Yes	No	Yes	No	Yes	No
51. Karnaugh maps.	Yes	No	Yes	No	Yes	No
52. Digital circuits	Yes	No	Yes	No	Yes	No
a. encoding.	Yes	No	Yes	No	Yes	No
b. decoding.	Yes	No	Yes	No	Yes	No
c. counters.	Yes	No	Yes	No	Yes	No
d. flip-flops.	Yes	No	Yes	No	Yes	No
e. multiplexing.	Yes	No	Yes	No	Yes	No
53. Linear circuits.	Yes	No	Yes	No	Yes	No
a. clocks.	Yes	No	Yes	No	Yes	No
b. op amps.	Yes	No	Yes	No	Yes	No
c. phase lock loop.	Yes	No	Yes	No	Yes	No
54. Basic digital computer theory and operation.	Yes	No	Yes	No	Yes	No
a. codes-BCD, gray code, excess 3.	Yes	No	Yes	No	Yes	No
b. ASCII and Hardot codes.	Yes	No	Yes	No	Yes	No
c. synchronous and asynchronous systems	Yes	No	Yes	No	Yes	No

		Properly Worded		Adequate Content		Item Complete	
	d. Logic memories.	Yes	No	Yes	No	Yes	No
	e. peripheral equipment.	Yes	No	Yes	No	Yes	No
55.	Computer Languages.	Yes	No	Yes	No	Yes	No
	a. BASIC	Yes	No	Yes	No	Yes	No
	b. COBOL	Yes	No	Yes	No	Yes	No
	c. FORTRAN	Yes	No	Yes	No	Yes	No
56.	Microconputers.	Yes	No	Yes	No	Yes	No
57.	Computer systems.	Yes	No	Yes	No	Yes	No
58.	Career opportunities if the electronics field.	Yes	No	Yes	No	Yes	No
59.	Apprenticeship programs available.	Yes	No	Yes	No	Yes	No

At the completion of the electronics program a student should be able to:

60.	Use standard resistor color code.	Yes	No	Yes	No	Yes	No
61.	Identify and use hand tools used in the electronic field.	Yes	No	Yes	No	Yes	No
62.	Read and understand schematic diagrams.	Yes	No	Yes	No	Yes	No
63.	Breadboard circuits from schematic diagrams.	Yes	No	Yes	No	Yes	No
64.	Design a printed circuit board from the schematic to a finished layout.	Yes	No	Yes	No	Yes	No
65.	Apply resist, etch, drill, mount components and solder a printed circuit board.	Yes	No	Yes	No	Yes	No
66.	Troubleshoot and repair a printed circuit board using a schematic diagram.	Yes	No	Yes	No	Yes	No
67.	Hand solder.	Yes	No	Yes	No	Yes	No
68.	Wirewrap a. Hand. b. power.	Yes	No	Yes	No	Yes	No

		Properly Worded		Adequate Content		Item Complete	
69.	Use fastener such as screws, bolts rivets, etc..	Yes	No	Yes	No	Yes	No
70.	Use basic sheet metal equipment such as punch, box and pan brake, shear and other sheet metal tools for basic fabrication.	Yes	No	Yes	No	Yes	No
71.	Use hand tools	Yes	No	Yes	No	Yes	No
	a. woodworking.	Yes	No	Yes	No	Yes	No
	b. metalworking.	Yes	No	Yes	No	Yes	No
72.	Use drill press	Yes	No	Yes	No	Yes	No
73.	Use bandsaw.	Yes	No	Yes	No	Yes	No
74.	Use the following equipment:						
	a. Analog multimeter.	Yes	No	Yes	No	Yes	No
	b. Digital multimeter.	Yes	No	Yes	No	Yes	No
	c. AF signal generator.	Yes	No	Yes	No	Yes	No
	d. RF signal generator.	Yes	No	Yes	No	Yes	No
	e. Function generator.	Yes	No	Yes	No	Yes	No
	f. Frequency counter.	Yes	No	Yes	No	Yes	No
	g. Oscilloscope.	Yes	No	Yes	No	Yes	No
	h. Color-bar generator.	Yes	No	Yes	No	Yes	No
	i. High-voltage probe.	Yes	No	Yes	No	Yes	No
	j. Transistor tester.	Yes	No	Yes	No	Yes	No
	k. Tube tester.	Yes	No	Yes	No	Yes	No
	l. Power supply.	Yes	No	Yes	No	Yes	No
75.	Make the following measurements using a multimeter.						
	a. AC or DC voltage.	Yes	No	Yes	No	Yes	No
	b. AC or DC current.	Yes	No	Yes	No	Yes	No
	c. Resistance.	Yes	No	Yes	No	Yes	No
76.	Test transistors	Yes	No	Yes	No	Yes	No
	a. transistor tester.	Yes	No	Yes	No	Yes	No
	b. ohmmeter.	Yes	No	Yes	No	Yes	No
77.	Test vacuum tubes.	Yes	No	Yes	No	Yes	No
78.	Use oscilloscope to measure voltage and frequency.	Yes	No	Yes	No	Yes	No
79.	Complete a color alignment on a TV.	Yes	No	Yes	No	Yes	No
80.	Align an AM or FM radio.	Yes	No	Yes	No	Yes	No
81.	Troubleshoot using an oscilloscope.	Yes	No	Yes	No	Yes	No

APPENDIX B

SUMMARY

OF

QUESTIONNAIRE BY PANEL OF EXPERTS

APPENDIX B

SUMMARY OF QUESTIONNAIRE BY PANEL OF EXPERTS

To summarize what the panel of experts said in regards to the rough draft of the questionnaire.

1. Specify how long the course will be.

2. In the objective statement, change the word "knowledge" to "understand".

3. Line item 3, add "DC" prior to "electron theory".

4. Line item 4, delete the word "conventional".

5. Add theory items to support the skills in "printed circuit board fabrication, soldering, wirewrap and test equipment usage".

6. Separate line item 6 and individualize.

7. Seperate line item 12 and individualize.

8. Combine line items 13 and 14.

9. Delete the word "theory" or change it to "basic concept" in most line items.

10. Add the word "basic" to most line items.

11. Move line item 16 ahead of line items 10 and 11.

12. Create a broad heading of "Overload protection devices" and include GFI (ground fault interrupt) for line item 17.

13. Add the word "codes" to line items 20 and 21.

14. Change line item 22 to "industrial/residential controls" and

add "numeric and RF controls".

15. Add 3 categories to cover line items 24-39. Include the following categories: "Receivers/Transceivers, Conductive communications, and Wireless communications".

16. Relocate line item 45 ahead of line item 40.

17. Create a line item of "transistors".

18. Change "Integrated Circuits" to "Difference between integrated circuit families".

19. Delete line items 48, 50, 51 and 54a.

20. Rearrange line items 54 and 55 and place under a central heading "Basic concepts of digital computers".

21. Break line item 56 down to "what, how, why and where".

22. Expand skill objective statement to include "four year program, high school student and one year course".

23. Add new line item "component identification".

24. Line item 61, add "basic" to "hand tools".

25. Line item 69, add "properly" to "use fastenters".

26. Line item 74, add "logic probe".

27. Delete line items 77, 79 and 80.

APPENDIX C

INSTRUMENT

GREECE
CENTRAL SCHOOL DISTRICT

PO Box 300, N. Greece, N.Y. 14515

1790 Latta Road
Greece, New York
(716) 621-1000

David B. Robinson
Superintendent of Schools

August 3, 1981

Dear Respondent:

Greece Central School is in the process of revising its electronics curriculum. At the present, Greece teaches three levels of electronics. Level One is a half-year course and teaches the fundamentals of electronics. Level Two is a full-year course and teaches deeper concepts than Level One, plus introduces the student to new material concerning the "state of the art" in electronics. Level Three is a half-year course which a student may take up to four times or two full years. It allows the student to experience different areas of electronics and to assist him/her in making a career decision in the electronics field.

Due to the rapid changes in the electronics field, Greece Central School, like many other schools, are possibly teaching "out of date" concepts. The purpose of this questionnaire is to gather data to determine if the concepts and experiences presented in the high school electronics programs are adequate for preparing students to make career decisions.

This study is being taken from a stratified random sample of the nearly one thousand industries in the greater Rochester area. In reviewing this questionnaire, we are asking you to rate how important are the objectives currently being taught. The rating breaks down as follows:

Essential:	Student must know to work in the electronics field.
Beneficial:	Not necessarily need to know, but must know where to find material in reference books.
Nice to Know:	Necessary only for background information
Limited Use:	No longer need to know to work in the electronics field, may appear in special cases.
Unimportant:	Material is no longer current in the electronics field, it has been superseded and/or deleted.

In reviewing the questionnaire, feel free to write on it to get your point across. All individual responses will be kept confidential.

Thank you for your cooperation.

Respectfully,

GREECE CENTRAL SCHOOL DISTRICT

James E. Good

James E. Good, District Supervisor
Vocational/Technical Education

Earl D. Gates
Electronics
Greece Olympia High School

JEGEDG:mjd
Enclosure

SURVEY OF ELECTRONIC OBJECTIVES

Directions: Please circle your response in evaluating the following objectives, based on the following data.

Essential: Student must know to work in the electronics field.

Beneficial: Not necessarily need to know, but must know where to find it in referece books.

Nice to Know: Necessary only for background information.

Limited use: No longer need to know to work in the electronics field, may appear in special cases.

Unimportant: Material no longer current in the electronics field, has been superseded and/or deleted.

At the completion of a comprehensive electronics program, the student will be able to demonstrate understanding of the basic concepts in the following areas:

	Essential	Beneficial	Nice to know	Limited use	Unimportant	Do not Write
1. Safety with electricity	5	4	3	2	1	____
2. Common electronic symbols as used with schematic diagrams	5	4	3	2	1	____
3. Printed circuit board layout	5	4	3	2	1	____
4. Printed circuit board fabrication	5	4	3	2	1	____
5. Troubleshooting techniques	5	4	3	2	1	____
6. Soldering	5	4	3	2	1	____
7. Wirewrap	5	4	3	2	1	____
8. Introduction to test equipment	5	4	3	2	1	____
9. General DC electron theory	5	4	3	2	1	____
10. Sources of electricity	5	4	3	2	1	____

	Essential	Beneficial	Nice to know	Limited use	Unimportant	Do not write
11. Ohm's Law	5	4	3	2	1	
12. Cells and batteries	5	4	3	2	1	
13. Series circuits	5	4	3	2	1	
14. Parallel circuits	5	4	3	2	1	
15. Series-parallel circuits	5	4	3	2	1	
16. Resistive circuit analysis	5	4	3	2	1	
17. AC principles and terms	5	4	3	2	1	
18. RL circuits	5	4	3	2	1	
19. RC circuits	5	4	3	2	1	
20. Resonance circuits	5	4	3	2	1	
21. Basic motor/generator concepts						
a. AC	5	4	3	2	1	
b. DC	5	4	3	2	1	
22. Basic transformer concepts	5	4	3	2	1	
23. Overload protection circuits (fuses, circuitbreakers, GFI)	5	4	3	2	1	
24. Residential wiring and codes	5	4	3	2	1	
25. Industrial wiring codes	5	4	3	2	1	
26. Industrial/residential controls (magnetic switch, numerical control, remote RF controls)	5	4	3	2	1	
27. Receivers/transceivers (amatuer radio, CB radio)	5	4	3	2	1	
28. Conductive communications (telephone, intercoms, PA systems)	5	4	3	2	1	
29. Wireless communications (AM/FM radio, radar, sonar)	5	4	3	2	1	

	Essential	Beneficial	Nice to know	Limited use	Unimportant	Do not write
30. Vacuum tubes	5	4	3	2	1	
31. Transistors	5	4	3	2	1	
32. Special semiconductors						
a. FET or MOSFET	5	4	3	2	1	
b. UJT	5	4	3	2	1	
c. SCR	5	4	3	2	1	
d. TRIAC	5	4	3	2	1	
33. Transistor amplification						
a. low power	5	4	3	2	1	
b. high power	5	4	3	2	1	
34. Basic transistor oscillators	5	4	3	2	1	
35. Basic transistor switching	5	4	3	2	1	
36. Basic power supply concepts						
a. half wave	5	4	3	2	1	
b. full wave	5	4	3	2	1	
c. filtering	5	4	3	2	1	
d. regulation	5	4	3	2	1	
37. Difference between IC families (TTL, CMOS)	5	4	3	2	1	
38. Basic digital electronics						
a. binary system	5	4	3	2	1	
b. octal system	5	4	3	2	1	
c. hexidecimal system	5	4	3	2	1	
39. Basic logic gates and symbols	5	4	3	2	1	
40. Basic digital circuits						
a. encoding	5	4	3	2	1	
b. decoding	5	4	3	2	1	
c. counters	5	4	3	2	1	
d. flip-flops	5	4	3	2	1	
e. multiplexing	5	4	3	2	1	
41. Basic linear circuits						
a. clocks	5	4	3	2	1	
b. op amps	5	4	3	2	1	
c. phase-lock-loop	5	4	3	2	1	

	Essential	Beneficial	Nice to know	Limited use	Unimportant	Do not write
42. Basic concepts of digital computers	5	4	3	2	1	____
a. ASCII	5	4	3	2	1	____
b. synchronous/asynchronous systems	5	4	3	2	1	____
c. logic memories	5	4	3	2	1	____
d. periperal equipment	5	4	3	2	1	____
e. computer lanuages (BASIC, COBOL, FORTRAN, APL)	5	4	3	2	1	____
43. Basic concepts of microprocessors	5	4	3	2	1	____
a. how and where used	5	4	3	2	1	____
b. how work	5	4	3	2	1	____
c. information input/output	5	4	3	2	1	____
44. Career opportunities in the electronic field.	5	4	3	2	1	____
45. Apprenticeship programs available	5	4	3	2	1	____

At the completion of a comprehensive four year program of one course per year, a high school student should be able to exhibit the following skills:

1. Use standard resistor color code	5	4	3	2	1	____
2. Identify components used in the electronic field.	5	4	3	2	1	____
3. Identify and use basic hand tools found in the electronic field.	5	4	3	2	1	____
4. Read and understand schematic diagrams	5	4	3	2	1	____
5. Breadboard circuits from schematic diagrams	5	4	3	2	1	____
6. Design a printed circuit board from the schematic to finished layout	5	4	3	2	1	____
7. Apply resist, etch, drill, mount components and solder a printed circuit board	5	4	3	2	1	____
8. Trouble shoot and repair a printed circuit board using a schematic diagram	5	4	3	2	1	____

	Essential	Beneficial	Nice to know	Limited use	Unimportant	Do not write
9. Hand solder	5	4	3	2	1	
10. Wirewrap (hand, power)	5	4	3	2	1	
11. Properly use fasteners such as bolts, screws, rivets, etc.	5	4	3	2	1	
12. Use basic sheet metal equipment such as punch, box and pan brake, shear and other sheet metal tools for basic fabrication	5	4	3	2	1	
13. Use basic woodworking and metal working hand tools	5	4	3	2	1	
14. Use drill press	5	4	3	2	1	
15. Use band saw	5	4	3	2	1	
16. Use the following test equipment						
a. analog multimeter	5	4	3	2	1	
b. digital multimeter	5	4	3	2	1	
c. AF signal generator	5	4	3	2	1	
d. RF signal generator	5	4	3	2	1	
e. function generator	5	4	3	2	1	
f. frequency counter	5	4	3	2	1	
g. oscilloscope	5	4	3	2	1	
h. TV color-bar generator	5	4	3	2	1	
i. high-voltage probe	5	4	3	2	1	
j. transistor tester	5	4	3	2	1	
k. Tube tester	5	4	3	2	1	
l. power supply	5	4	3	2	1	
m. logic probe	5	4	3	2	1	
17. Make the following measurements using a multimeter						
a. AC or DC voltage	5	4	3	2	1	
b. AC or DC current	5	4	3	2	1	
c. resistance	5	4	3	2	1	
18. Use an oscilloscope to measure voltage and frequency	5	4	3	2	1	

19. Test transistors						
a. transistor tester	5	4	3	2	1	____
b. using an ohmmeter	5	4	3	2	1	____
20. Troubleshoot using						
a. multimeter	5	4	3	2	1	____
b. oscilloscope	5	4	3	2	1	____
c. logic probe	5	4	3	2	1	____

Rank the following areas in the electronic field, in the order, you feel are most important in teaching basic concepts to high school students. (use 1 as most important)

1. General Electronics _____
2. Communications _____
3. Solid-state Electronics _____
4. Digital Electronics _____
5. Computer Electronics _____
6. Industrial Electronics _____
7. Linear Electronics _____
8. Other _____ _____

Please fill in the following:

Company Name _____

Number of employees at this location _____

Title of person filling out this form _____

Thank you for your help. All individual responses will be kept confidential.

APPENDIX D

LIST OF INDUSTRIES

USED FOR SURVEY

APPENDIX D

LIST OF INDUSTRIES USED FOR SURVEY

The following are the companies used in this survey. The number of employees are not shown at the request of several of the companies.

Eastman Kodak Apparatus Division

Eastman Kodak Park Division

Edmac Associates

Electronic Instrument Company

Electronic Navigation Industries, Inc.

General Circuits

General Electric

General Railroad Signal

Harris Corporation

Metro Circuits Inc.

Pure Water Works, Monroe County

Radionics Incorporated

Scientific Radio System

SenDec

Stromberg Carlson

Sybron/Taylor Instrument

Sykes Datatronics

Transmation Inc.

Xerox Corporation

APPENDIX E

NUMERICAL SUMMARY OF

SURVEY OF ELECTRONIC OBJECTIVES

APPENDIX E

NUMERICAL SUMMARY OF SURVEY OF ELECTRONIC OBJECTIVES

5.00 Essential: Student must know to work in the electronics field

4.00 Beneficial: Not necessarily need to know, but must know where to find information in reference books.

3.00 Nice to Know: Necessary only for background information.

2.00 Limited use: No longer need to know to work in the electronics field, may appear in special cases.

1.00 Unimportant: Material no longer current in the electronics field, has been superseded and/or deleted.

At the completion of a comprehensive electronics program, the student will be able to demonstrate understanding of the basic concepts in the following areas:

	Management	Supervisors	Engineers	Technicians
1. Safety with electricity	4.83	4.91	4.56	5.00
2. Common electronic symbols as used with schematic diagrams	4.75	4.82	4.78	5.00
3. Printed circuit board layout	3.67	3.82	3.22	3.00
4. Printed circuit board fabrication	3.17	3.27	3.00	3.50
5. Troubleshooting techniques	4.58	4.73	5.00	5.00
6. Soldering	4.83	4.55	4.33	5.00
7. Wirewrap	4.00	4.00	3.89	4.00
8. Introduction to test equipment	4.42	4.82	4.44	5.00
9. General DC electron theory	4.17	4.82	4.22	5.00
10. Sources of electricity	3.75	4.27	3.33	4.50

	Management	Supervisors	Engineers	Technicians
11. Ohm's Law	4.75	4.82	5.00	5.00
12. Cells and batteries	4.08	3.91	3.44	4.00
13. Series circuits	4.50	4.91	4.89	5.00
14. Parallel circuits	4.50	4.91	4.89	5.00
15. Series-parallel circuits	4.50	4.91	4.73	5.00
16. Resistive circuit analysis	4.42	4.73	4.78	4.75
17. AC principles and terms	4.42	4.91	4.56	5.00
18. RL circuits	4.25	4.64	4.33	4.75
19. RC circuits	4.25	4.73	4.33	4.75
20. Resonance circuits	4.17	4.64	4.22	4.50
21. Basic motor/generator concepts				
a. AC	3.16	4.09	3.44	3.75
b. DC	3.16	4.09	3.44	3.75
22. Basic transformer concepts	3.92	4.73	3.89	5.00
23. Overload protection circuits (fuses, circuitbreakers, GFI)	4.25	4.18	3.89	3.75
24. Residential wiring and codes	2.83	2.64	2.67	2.50
25. Industrial wiring codes	2.83	3.45	2.89	2.75
26. Industrial/residential controls (magnetic switch, numerical control, remote RF controls)	2.75	3.45	3.22	3.00
27. Receivers/transceivers (amatuer radio, CB radio)	3.25	3.09	3.44	3.00
28. Conductive communications (telephone, intercoms, PA systems)	3.42	3.09	3.22	3.25
29. Wireless communications (AM/FM radio, radar, sonar)	3.42	3.50	3.89	3.25

	Management	Supervisors	Engineers	Technicians
30. Vacuum tubes	2.50	2.45	2.44	2.75
31. Transistors	4.50	4.73	4.78	5.00
32. Special semiconductors				
a. FET or MOSFET	4.25	4.64	4.44	4.50
b. UJT	4.25	4.36	4.11	4.25
c. SCR	4.25	4.36	4.33	4.25
d. TRIAC	4.25	4.27	3.44	4.25
33. Transistor amplification				
a. low power	4.33	4.82	4.67	5.00
b. high power	4.25	4.73	4.33	4.75
34. Basic transistor oscillators	4.17	4.36	4.22	4.25
35. Basic transistor switching	4.25	4.73	4.44	4.75
36. Basic power supply concepts				
a. half wave	4.67	4.55	4.11	4.75
b. full wave	4.67	4.73	4.33	4.75
c. filtering	4.67	4.82	4.44	4.75
d. regulation	4.67	4.82	4.44	4.75
37. Difference between IC families (TTL, CMOS)	4.33	4.64	4.44	4.50
38. Basic digital electronics				
a. binary system	4.58	4.55	4.33	4.75
b. octal system	4.25	4.45	4.11	4.75
c. hexidecimal system	4.25	4.55	4.11	4.75
39. Basic logic gates and symbols	4.50	4.91	4.78	5.00
40. Basic digital circuits				
a. encoding	4.25	4.64	4.33	4.50
b. decoding	4.25	4.64	4.33	4.50
c. counters	4.33	4.55	4.56	4.75
d. flip-flops	4.33	4.91	4.56	4.75
e. multiplexing	4.33	4.64	4.44	4.50
41. Basic linear circuits				
a. clocks	4.42	4.73	4.44	4.50
b. op amps	4.33	4.91	4.56	4.50
c. phase-lock-loop	4.25	4.55	4.00	4.25

	Management	Supervisors	Engineers	Technicians
42. Basic concepts of digital computers	4.17	3.55	4.22	4.25
a. ASCII	4.08	3.27	4.00	3.75
b. synchronous/asynchronous systems	4.25	3.73	4.00	3.75
c. logic memories	4.08	3.91	4.00	3.75
d. periperal equipment	4.00	3.73	3.78	4.00
e. computer lanuages (BASIC, COBOL, FORTRAN, APL)	4.00	3.64	3.78	3.25
43. Basic concepts of microprocessors	4.25	4.18	4.67	4.50
a. how and where used	4.17	4.45	4.22	4.25
b. how work	4.08	4.55	4.44	4.00
c. information input/output	4.00	4.45	4.44	3.25
44. Career opportunities in the electronic field.	4.33	4.18	3.11	4.00
45. Apprenticeship programs available	4.25	4.00	3.33	4.00

At the completion of a comprehensive four year program of one course per year, a high school student should be able to exhibit the following skills:

1. Use standard resistor color code	4.58	4.73	4.78	5.00
2. Identify components used in the electronic field.	5.00	4.64	4.78	5.00
3. Identify and use basic hand tools found in the electronic field.	4.75	4.55	4.22	5.00
4. Read and understand schematic diagrams	4.75	4.82	4.89	5.00
5. Breadboard circuits from schematic diagrams	4.67	4.64	4.56	4.50
6. Design a printed circuit board from the schematic to finished layout	3.83	3.55	3.33	3.75
7. Apply resist, etch, drill, mount components and solder a printed circuit board	3.67	3.18	3.22	3.25
8. Trouble shoot and repair a printed circuit board using a schematic diagram	4.75	4.64	4.78	5.00

	Management	Supervisors	Engineers	Technicians
9. Hand solder	5.00	4.27	4.67	5.00
10. Wirewrap (hand, power)	4.25	3.63	4.11	4.00
11. Properly use fasteners such as bolts, screws, rivets, etc.	4.33	3.91	3.78	4.25
12. Use basic sheet metal equipment such as punch, box and pan brake, shear and other sheet metal tools for basic fabrication	3.79	3.09	3.33	3.50
13. Use basic woodworking and metal working hand tools	3.88	2.91	3.11	3.50
14. Use drill press	3.88	3.55	3.22	3.50
15. Use band saw	3.54	2.82	3.11	3.00
16. Use the following test equipment				
a. analog multimeter	4.83	4.36	4.78	5.00
b. digital multimeter	4.92	4.82	4.67	5.00
c. AF signal generator	4.50	4.64	4.22	4.75
d. RF signal generator	4.42	4.64	3.89	4.50
e. function generator	4.54	4.27	4.22	5.00
f. frequency counter	4.67	4.64	4.56	5.00
g. oscilloscope	4.92	4.91	4.89	5.00
h. TV color-bar generator	3.91	3.45	3.33	3.00
i. high-voltage probe	4.25	3.91	3.67	4.25
j. transistor tester	4.75	4.18	3.89	4.25
k. Tube tester	4.00	3.55	2.78	3.00
l. power supply	4.92	4.73	4.78	5.00
m. logic probe	4.75	4.36	4.44	4.25
17. Make the following measurements using a multimeter				
a. AC or DC voltage	5.00	4.91	5.00	5.00
b. AC or DC current	5.00	4.91	4.78	4.75
c. resistance	5.00	4.91	4.67	5.00
18. Use an oscilloscope to measure voltage and frequency	4.75	4.91	4.89	5.00

	Management	Supervisors	Engineers	Technicians
19. Test transistors				
a. transistor tester	4.75	4.27	4.11	4.25
b. using an ohmmeter	4.83	4.73	4.56	5.00
20. Troubleshoot using				
a. multimeter	4.83	4.82	4.89	5.00
b. oscilloscope	5.00	4.91	4.89	5.00
c. logic probe	4.83	4.45	4.33	4.25

APPENDIX F

NUMERICAL TOTAL OF

SURVEY OF ELECTRONIC OBJECTIVES

APPENDIX F

NUMERICAL TOTAL OF SURVEY OF ELECTRONIC OBJECTIVES

5.00 Essential: Students must know to work in the electronics field.

4.00 Beneficial: Not necessarily need to know, but must know where to find it in reference books.

3.00 Nice to Know: Necessary only for background information.

2.00 Limited use: No longer need to know to work in electronics field, may appear in special cases.

1.00 Unimportant: Material no longer current in the electronics field, has been superseded and/or deleted.

At the completion of a comprehensive electronics program, the student will be able to demonstrate understanding of the basic concepts in the following areas:

	Essential	Beneficial	Nice to know	Limited use	Unimportant	Overall Rating
1. Safety with electricity	5	4	3	2	1	4.81
2. Common electronic symbols as used with schematic diagrams	5	4	3	2	1	4.81
3. Printed circuit board layout	5	4	3	2	1	3.53
4. Printed circuit board fabrication	5	4	3	2	1	3.19
5. Troubleshooting techniques	5	4	3	2	1	4.77
6. Soldering	5	4	3	2	1	4.64
7. Wirewrap	5	4	3	2	1	3.97
8. Introduction to test equipment	5	4	3	2	1	4.61
9. General DC electron theory	5	4	3	2	1	4.47
10. Sources of electricity	5	4	3	2	1	3.89

	Essential	Beneficial	Nice to Know	Limited use	Unimportant	Overall Rating
11. Ohm's Law	5	4	3	2	1	4.86
12. Cells and batteries	5	4	3	2	1	3.86
13. Series circuits	5	4	3	2	1	4.77
14. Parallel circuits	5	4	3	2	1	4.77
15. Series-parallel circuits	5	4	3	2	1	4.75
16. Resistive circuit analysis	5	4	3	2	1	4.64
17. AC principles and terms	5	4	3	2	1	4.67
18. RL circuits	5	4	3	2	1	4.44
19. RC circuits	5	4	3	2	1	4.47
20. Resonance circuits	5	4	3	2	1	4.36
21. Basic motor/generator concepts						
a. AC	5	4	3	2	1	3.58
b. DC	5	4	3	2	1	3.58
22. Basic transformer concepts	5	4	3	2	1	4.27
23. Overload protection circuits (fuses, circuitbreakers, GFI)	5	4	3	2	1	4.08
24. Residential wiring and codes	5	4	3	2	1	2.69
25. Industrial wiring codes	5	4	3	2	1	3.03
26. Industrial/residential controls (magnetic switch, numerical control, remote RF controls)	5	4	3	2	1	3.11
27. Receivers/transceivers (amatuer radio, CB radio)	5	4	3	2	1	3.22
28. Conductive communications (telephone, intercoms, PA systems)	5	4	3	2	1	3.25
29. Wireless communications (AM/FM radio, radar, sonar)	5	4	3	2	1	3.54

	Essential	Beneficial	Nice to Know	Limited Use	Unimportant	Overall Rating
30. Vacuum tubes	5	4	3	2	1	2.50
31. Transistors	5	4	3	2	1	4.69
32. Special semiconductors						
a. FET or MOSFET	5	4	3	2	1	4.44
b. UJT	5	4	3	2	1	4.25
c. SCR	5	4	3	2	1	4.31
d. TRIAC	5	4	3	2	1	4.06
33. Transistor amplification						
a. low power	5	4	3	2	1	4.64
b. high power	5	4	3	2	1	4.47
34. Basic transistor oscillators	5	4	3	2	1	4.25
35. Basic transistor switching	5	4	3	2	1	4.50
36. Basic power supply concepts						
a. half wave	5	4	3	2	1	4.50
b. full wave	5	4	3	2	1	4.61
c. filtering	5	4	3	2	1	4.67
d. regulation	5	4	3	2	1	4.67
37. Difference between IC families (TTL, CMOS)	5	4	3	2	1	4.47
38. Basic digital electronics						
a. binary system	5	4	3	2	1	4.53
b. octal system	5	4	3	2	1	4.33
c. hexidecimal system	5	4	3	2	1	4.36
39. Basic logic gates and symbols	5	4	3	2	1	4.75
40. Basic digital circuits						
a. encoding	5	4	3	2	1	4.42
b. decoding	5	4	3	2	1	4.42
c. counters	5	4	3	2	1	4.50
d. flip-flops	5	4	3	2	1	4.61
e. multiplexing	5	4	3	2	1	4.47
41. Basic linear circuits						
a. clocks	5	4	3	2	1	4.52
b. op amps	5	4	3	2	1	4.58
c. phase-lock-loop	5	4	3	2	1	4.28

	Essential	Beneficial	Nice to know	Limited use	Unimportant	Overall Rating
42. Basic concepts of digital computers	5	4	3	2	1	4.00
a. ASCII	5	4	3	2	1	3.78
b. synchronous/asynchronous systems	5	4	3	2	1	3.97
c. logic memories	5	4	3	2	1	3.97
d. periperal equipment	5	4	3	2	1	3.86
e. computer lanuages (BASIC, COBOL, FORTRAN, APL)	5	4	3	2	1	3.75
43. Basic concepts of microprocessors	5	4	3	2	1	4.36
a. how and where used	5	4	3	2	1	4.28
b. how work	5	4	3	2	1	4.28
c. information input/output	5	4	3	2	1	4.17
44. Career opportunities in the electronic field.	5	4	3	2	1	3.94
45. Apprenticeship programs available	5	4	3	2	1	3.92

At the completion of a comprehensive four year program of one course per year, a high school student should be able to exhibit the following skills:

1. Use standard resistor color code	5	4	3	2	1	4.86
2. Identify components used in the electronic field.	5	4	3	2	1	4.89
3. Identify and use basic hand tools found in the electronic field.	5	4	3	2	1	4.58
4. Read and understand schematic diagrams	5	4	3	2	1	4.83
5. Breadboard circuits from schematic diagrams	5	4	3	2	1	4.61
6. Design a printed circuit board from the schematic to finished layout	5	4	3	2	1	3.61
7. Apply resist, etch, drill, mount components and solder a printed circuit board	5	4	3	2	1	3.36
8. Trouble shoot and repair a printed circuit board using a schematic diagram	5	4	3	2	1	4.25

		Essential	Beneficial	Nice to know	Limited use	Unimportant	Overall Rating
9.	Hand solder	5	4	3	2	1	4.69
10.	Wirewrap (hand, power)	5	4	3	2	1	4.00
11.	Properly use fasteners such as bolts, screws, rivets, etc.	5	4	3	2	1	4.06
12.	Use basic sheet metal equipment such as punch, box and pan brake, shear and other sheet metal tools for basic fabrication	5	4	3	2	1	3.43
13.	Use basic woodworking and metal working hand tools	5	4	3	2	1	3.35
14.	Use drill press	5	4	3	2	1	3.57
15.	Use band saw	5	4	3	2	1	3.15
16.	Use the following test equipment						
	a. analog multimeter	5	4	3	2	1	4.69
	b. digital multimeter	5	4	3	2	1	4.83
	c. AF signal generator	5	4	3	2	1	4.50
	d. RF signal generator	5	4	3	2	1	4.36
	e. function generator	5	4	3	2	1	4.43
	f. frequency counter	5	4	3	2	1	4.67
	g. oscilloscope	5	4	3	2	1	4.92
	h. TV color-bar generator	5	4	3	2	1	3.53
	i. high-voltage probe	5	4	3	2	1	4.00
	j. transistor tester	5	4	3	2	1	4.31
	k. Tube tester	5	4	3	2	1	3.44
	l. power supply	5	4	3	2	1	4.83
	m. logic probe	5	4	3	2	1	4.50
17.	Make the following measurements using a multimeter						
	a. AC or DC voltage	5	4	3	2	1	4.97
	b. AC or DC current	5	4	3	2	1	4.89
	c. resistance	5	4	3	2	1	4.89
18.	Use an oscilloscope to measure voltage and frequency	5	4	3	2	1	4.86

	Essential	Beneficial	Nice to know	Limited use	Unimportant	Overall Results
19. Test transistors						
a. transistor tester	5	4	3	2	1	4.39
b. using an ohmmeter	5	4	3	2	1	4.75
20. Troubleshoot using						
a. multimeter	5	4	3	2	1	4.86
b. oscilloscope	5	4	3	2	1	4.94
c. logic probe	5	4	3	2	1	4.52

APPENDIX G

PERCENTAGE OF AGREEMENT AMONG PERSONNEL RESPONDING TO SURVEY OF ELECTRONIC OBJECTIVES

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APPENDIX G

PERCENTAGE OF AGREEMENT AMONG PERSONNEL RESPONDING TO SURVEY OF ELECTRONIC OBJECTIVES

Each column is tabulated separately from the totals of the raw scores received. The overall column might not average the summation of the other columns due to its being derived from the total of the raw scores.

At completion of a comprehensive electronics program, a student will be able to demonstrate understanding of the basic concepts in the following areas:

	Management	Supervisors	Engineers	Technicians	Overall
1. Safety with electricity	97	98	91	100	96
2. Common electronic symbols as used with schematic diagrams	95	96	96	100	96
3. Printed circuit board layout	73	76	64	60	70
4. Printed circuit board fabrication	63	65	60	70	64
5. Troubleshooting techniques	92	95	100	100	96
6. Soldering	97	91	87	100	93
7. Wirewrap	80	80	78	80	79
8. Introduction to test equipment	88	96	89	100	92
9. General DC electron theory	83	96	84	100	89
10. Sources of electricity	75	85	67	90	78

		Management	Supervisors	Engineers	Technicians	Overall
11.	Ohm's Law	95	96	100	100	97
12.	Cells and batteries	82	78	69	80	77
13.	Series circuits	90	98	98	100	96
14.	Parallel circuits	90	98	98	100	96
15.	Series-parallel circuits	90	98	96	100	95
16.	Resistive circuit analysis	88	95	96	95	93
17.	AC principles and terms	88	98	91	100	93
18.	RL circuits	85	93	87	95	89
19.	RC circuits	85	95	87	95	89
20.	Resonance circuits	83	93	84	90	87
21.	Basic motor/generator concepts					
	a. AC	63	82	69	75	72
	b. DC	63	82	69	75	72
22.	Basic transformer concepts	78	95	78	100	86
23.	Overload protection circuits (fuses, circuitbreakers, GFI)	85	84	78	75	82
24.	Residential wiring and codes	57	53	53	50	54
25.	Industrial wiring codes	57	69	58	55	61
26.	Industrial/residential controls (magnetic switch, numerical control, remote RF controls)	55	69	64	60	62
27.	Receivers/transceivers (amatuer radio, CB radio)	65	62	69	60	64
28.	Conductive communications (telephone, intercoms, PA systems)	68	62	64	65	65
29.	Wireless communications (AM/FM radio, radar, sonar)	68	70	78	65	71

	Management	Supervisors	Engineers	Technicians	Overall
30. Vacuum tubes	50	49	49	55	50
31. Transistors	90	95	96	100	94
32. Special semiconductors					
a. FET or MOSFET	85	93	89	90	89
b. UJT	85	87	82	85	85
c. SCR	85	87	87	85	86
d. TRIAC	85	85	69	85	81
33. Transistor amplification					
a. low power	87	96	93	100	93
b. high power	85	95	87	95	89
34. Basic transistor oscillators	83	87	84	85	85
35. Basic transistor switching	85	95	89	95	90
36. Basic power supply concepts					
a. half wave	93	91	82	95	90
b. full wave	93	95	87	95	92
c. filtering	93	96	89	95	93
d. regulation	93	96	89	95	93
37. Difference between IC families (TTL, CMOS)	87	93	89	90	90
38. Basic digital electronics					
a. binary system	92	91	87	95	90
b. octal system	85	89	82	95	87
c. hexidecimal system	85	91	82	95	87
39. Basic logic gates and symbols	90	98	96	100	95
40. Basic digital circuits					
a. encoding	85	93	87	90	88
b. decoding	85	93	87	90	88
c. counters	87	91	91	95	90
d. flip-flops	87	98	91	95	92
e. multiplexing	87	93	89	90	89
41. Basic linear circuits					
a. clocks	88	95	89	90	91
b. op amps	87	98	91	90	92
c. phase-lock-loop	85	91	80	85	86

	Management	Supervisors	Engineers	Technicians	Overall
42. Basic concepts of digital computers	83	71	84	83	80
a. ASCII	82	65	80	75	76
b. synchronous/asynchronous systems	85	75	80	75	79
c. logic memories	82	78	80	75	79
d. periperal equipment	80	75	76	80	77
e. computer lanuages (BASIC, COBOL, FORTRAN, APL)	80	73	76	65	75
43. Basic concepts of microprocessors	85	84	93	90	87
a. how and where used	83	89	84	85	86
b. how work	82	91	89	80	86
c. information input/output	80	89	89	65	83
44. Career opportunities in the electronic field.	87	84	62	80	79
45. Apprenticeship programs available	85	80	67	80	78

At the completion of a comprehensive four year program of one course per year, a high school student should be able to exhibit the following skills:

1. Use standard resistor color code	92	95	96	100	97
2. Identify components used in the electronic field.	100	93	96	100	98
3. Identify and use basic hand tools found in the electronic field.	95	91	84	100	92
4. Read and understand schematic diagrams	95	96	98	100	97
5. Breadboard circuits from schematic diagrams	93	93	91	90	92
6. Design a printed circuit board from the schematic to finished layout	77	71	67	75	72
7. Apply resist, etch, drill, mount components and solder a printed circuit board	73	64	64	65	67
8. Trouble shoot and repair a printed circuit board using a schematic diagram	95	93	96	100	95

	Management	Supervisors	Engineers	Technicians	Overall
9. Hand solder	100	85	93	100	94
10. Wirewrap (hand, power)	85	73	82	80	80
11. Properly use fasteners such as bolts, screws, rivets, etc.	87	78	76	85	81
12. Use basic sheet metal equipment such as punch, box and pan brake, shear and other sheet metal tools for basic fabrication	76	62	67	70	69
13. Use basic woodworking and metal working hand tools	78	58	62	70	67
14. Use drill press	78	71	64	70	71
15. Use band saw	71	56	62	60	63
16. Use the following test equipment					
a. analog multimeter	97	87	96	100	94
b. digital multimeter	98	96	93	100	97
c. AF signal generator	90	93	84	95	90
d. RF signal generator	88	93	78	90	87
e. function generator	91	85	84	100	89
f. frequency counter	93	93	91	100	93
g. oscilloscope	98	98	98	100	98
h. TV color-bar generator	78	69	67	60	71
i. high voltage probe	85	78	73	85	80
j. transistor tester	95	84	78	85	85
k. Tube tester	80	71	56	60	69
l. power supply	98	95	96	100	97
m. logic probe	95	87	89	85	90
17. Make the following measurements using a multimeter					
a. AC or DC voltage	100	98	100	100	99
b. AC or DC current	100	98	96	95	96
c. resistance	100	98	93	100	98
18. Use an oscilloscope to measure voltage and frequency	95	98	98	100	97

	Management	Supervisors	Engineers	Technicians	Overall
19. Test transistors					
a. transistor tester	95	85	82	85	[illegible]
b. using an ohmmeter	97	95	91	100	[illegible]
20. Troubleshoot using					
a. multimeter	97	96	98	100	[illegible]
b. oscilloscope	100	98	98	100	[illegible]
c. logic probe	97	89	87	85	[illegible]

APPENDIX H

HIERARCHY OF IMPORTANCE OF BASIC CONCEPTS

APPENDIX H

HIERARCHY OF IMPORTANCE OF BASIC CONCEPTS

The following areas in the electronic field are shown ranked in the order each group tought was important. The overall column is a summation of all the groups.

	Management	Supervisors	Engineers	Technicians	Overall
1. General Electronics	1	1	3	1	1
2. Communications	7	7	6	7	7
3. Solid-state Electronics	3	2	1	2	2
4. Digital Electronics	2	3	2	4	3
5. Computer Electronics	5	5	5	5	5
6. Industrial Electronics	6	6	7	5	6
7. Linear Electronics	4	4	4	3	4

APPENDIX I

COMPARISON OF SURVEY RESULTS

WITH

A CURRENT ELECTRONICS PROGRAM

APPENDIX I

COMPARISON OF SURVEY RESULTS WITH A CURRENT ELECTRONICS PROGRAM

Knowledge Items

Survey Items	Greece Electronics Program	Essential Items	Essential But Not Taught	Non-Essential But Taught
1.		X		
2.	L2	X		
3.	L1, L2			X
4.	L1, L2			X
5.	L1	X		
6.	L1, L2	X		
7.				
8.		X	X	
9.	L1, L2			
10.	L1	X		
11.	L1	X		
12.	L1			X
13.	L1	X		
14.	L1	X		
15.	L1	X		
16.		X	X	
17.	L1	X		

Survey Items	Greece Electronics Program	Essential Items	Essential But Not Taught	Non-Essential But Taught
18.	L1	X		
19.	L1	X		
20.	L2	X		
21a.	L1			X
21b.	L1			X
22.	L1	X		
23.		X	X	
24.	L1			X
25.				
26.				
27.	L3			X
28.	L3			X
29.	L1, L2, L3			X
30.	L2			X
31.	L2	X		
32a.	L2	X		
32b.	L2	X		
32c.	L2	X		
32d.	L2	X		
33a.	L2	X		
33b.	L2	X		
34.	L2	X		
35.		X	X	

Survey Items	Greece Electronics Program	Essential Items	Essential But Not Taught	Non-Essential But Taught
36a.		X	X	
36b.		X	X	
36c.		X	X	
36d.	L2	X		
37.	L3	X		
38a.	L3	X		
38b.	L3	X		
38c.	L3	X		
39.	L3	X		
40a.	L3	X		
40b.	L3	X		
40c.	L3	X		
40d.	L3	X		
40e.	L3	X		
41a.	L3	X		
41b.	L2, L3	X		
41c.	L3	X		
42.				
42a.				
42b.				
42c.				
42d.				
42e.				

Survey Items	Greece Electronics Program	Essential Items	Essential But Not Taught	Non-Essential But Taught
43.	L3	X		
43a.	L3	X		
43b.	L3	X		
43c.	L3	X		
44.				
45.				

Skill Items

Survey Items	Greece Electronics Program	Essential Items	Essential But Not Taught	Non-Essential But Taught
1.	L1	X		
2.		X	X	
3.	L1	X		
4.	L1	X		
5.	L1	X		
6.	L1			X
7.	L1			X
8.	L1	X		
9.	L1	X		
10.	L1			X
11.		X	X	
12.				
13.				

Survey Items	Greece Electronic Program	Essential Items	Essential But Not Taught	Non-Essential But Taught
14.	L1			X
15.				
16a.		X	X	
16b.	L1	X		
16c.	L2	X		
16d.	L2	X		
16e.		X	X	
16f.		X	X	
16g.	L2	X		
16h.				
16i.				
16j.	L2	X		
16k.	L1, L2			X
16l.	L1, L2	X		
16m.		X	X	
17a.	L1, L2	X		
17b.	L2	X		
17c.	L2	X		
18.		X	X	
19a.		X	X	
19b.		X	X	
20a.	L1	X		
20b.		X	X	
20c.		X	X	